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AUTOMATION IN CARTOGRAPHY

By Erwin GIGAS

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AUTOMATION IN CARTOGRAPHY

by Erwin GIGAS

With the continuously increasing quality of cartographic products and with the increasing lack of personnel, automation in cartography is more and more necessary.

Those who know that still today cartography is a product of intelligence, artistic perception, and decades of applied talents, will not deny that many prejudices have yet to be overcome. But, nevertheless, the last years proved that admirable services have been rendered by the large electronic computers - services, which could never be accomplished without them. Even music can be composed automatically, as has recently been demonstrated during the International Congress on Data Processing at Munich. Even art has to follow certain laws if we shall feel it to be harmonic. In his paper on the forthcoming rigorous introduction of automation Director HÄRRY wrote: "Automation in the hands of hedge-lawyers would become a plague; automation as a mission of civilization is a benefit." Already at the beginning of his paper, presented to the Congress of the International Federation of Surveyors in 1962 in Vienna, Dr. Härry cited Friedrich NAUMANN: "Mankind stands at the beginning and in the development of new forms of life. The dreamlike wonderful idea of the machine age, which only creates free and great characters floats above all things". It would be a desecration, a sin against our own feeling for responsibility, if we were not ready in this important period of development to keep pace with the new ideas, to learn how to profit by the new machines. But we should not be slaves of these automatons, but we should make them render always new miraculous services by means of our spirit released from the fetters of sad monotony.

In a nearly imperceptible way automation has been introduced into several fields of cartography during the past years. At first we think of the simple procedure of AUTOMATIC MAP PLOTTING. Coordinates punched into cards or tapes control the spindles of the "Koordinatograph" In the "Koordimat" of the Zeiss-Aerotopograph Company each fixed point is checked by comparison between the spindle values and the given values in the arithmetic unit before the point is plotted. With the automatic

Coordinatograph of the Zuse Company the computer coupled with this instrument derives the new coordinates from the spindle movements. In case of an error exceeding 1/20 mm, the Coordinatograph stops and indicates the error by lightening of a red lamp. With the latest automatic plotting instrument of the Zuse Company, the Z 64, the control is made by return to the initial value. The punched tape for the automatic processing of the programme is produced in a computer, e.g. in the Zuse 23. But a computer of different type may be used as well. The programmation is simplified by the fact that certain subprogrammes are already available. If no computer is at hand, the Graphomat may be provided with an additional transistor device, in which all additional programmes are already stored.

Now, what kind of work can be executed by means of the Graphomat, except automatic drawing of points from coordinates? Each graticule or grid of any projection can automatically be drawn. National boundaries e.g. can be stored in programmes and then automatically be drawn in Mercator or conic projection etc. in any desired scale. Also plans only consisting of lines as e.g. cadastral maps, can also be drawn automatically. If the scale of the map has to be changed e.g. from 1:500 to 1:1 000, the Graphomat will do this work automatically and if need be, the projection can also be changed. The essential fact is that if a programme is available and has been checked, all maps derived thereof may be assumed to be correct, thus saving the time for checking a drawing by hand.

When information is available in form of figures, e.g. the three space coordinates of a point, these data may be used for drawing the contour lines or to derive a complete map thereof.

This instrument is rather new, and very often it can be stated that after such an instrument has been constructed for a certain purpose, it may be useful for some other unforeseen purposes as well.

Various drawing pencils and pens, as well as chisels for coat scribing can be inserted into the drawing head. Figures of different types can automatically be written. Here the pencil is guided by the so-called "memory" of the machine in the same way as the hand is guided by the human brain.

Furthermore, an electric eye may be installed into the drawing head in order to retain the course of lines automatically for a later use of these data for generalization purposes.

Such an all-round instrument found a wide-spread interest with other firms. The firm Dennert + Pape, Hamburg, will cooperate with the Dr.-Ing. Perthen Company, Hannover, in designing a similar instrument with Perthronic control.

It may be expected that the noble competition of inventors and designers will accelerate the development of automation. In the field of automatic lettering and drawing of symbols etc. we may expect some progress in the future.

REPRODUCTION. Today the cartographer cannot work without the various auxiliary means which photography and photographic printing offer to him. Within the scope of our topic "Automation", the elegant solution of automatic precise setting by electronic means of the Hoh + Hahne Company, as well as by a multi-spindle system of the Klimsch Company, shall be mentioned here. (Magnification 4:1 and reduction 1:10 is possible in sizes extending from 100 x 100 cm to 125 x 150 cm.)

Both firms have constructed an instrument, which magnifies or reduces the line widths by means of a rotating totter lens system in front of the objective lens. This instrument is called "Optischer Umformer OU 1" (Optical transformer) by the Hoh + Hahne Company and "Variomat" by the Klimsch Company. This instrument can also be used for isolating of lettering and for automatical elimination of contour lines in generalization.

Another problem can be automatically solved by means of the Variograph: In a map distorted to different extent in two directions, all distortions can be eliminated, retaining the original sharp definition by slotted exposure with simultaneous minor movement of the original or of the copy holder, or even with simultaneous minor rotation. Also superelevations can be drawn automatically. This instrument proved valuable for drawings in railway and road construction.

Nothing shall be mentioned here about the variety of possibilities in cartography in this epoch of coat scribing and strip masking. Many reports are available on these subjects. But without doubt this development facilitated the introduction of automation in cartography.

PHOTOGRAMMETRY. In former times the cartographer did not take much interest in the production of the original drawing (planetable work). He received the planetable sheet from the topographer, where everything was exactly prescribed by means of colours and symbols, so that he only had to engrave, to scribe, or to draw the given image in an artistic manner by his skilful hand.

At present things are different. Machines took over a consíderable part of the cartographer's work. In photogrammetry one is on the best way to introduce automation to an ever increasing extent. The automatic plotting of contour lines may be considered as a sólved problem by the invention of the "Stereomat". A skilful photogrammetrist is able to scribe the culture plate directly with the stereoplanigraph in such a way that the cartographer has only to make minor corrections and additions.

In the Institute of Applied Geodesy air photographs of the Near East in the scale of 1:40 000 were directly plotted in the Planigraph in 1:25 000 scale, colour-separated, i.e. the plates for culture, contours, and drainage were scribed on separate coated foils. These plottings were so excellent that they could immediately be used as originals for printing. The time required for plotting increased only slightly, namely by 10 p.c., although greater demands have been made on the operator as to a very careful tracing of lines.

These excellent results induced a continuation of these experiments. In the same way we have tried to use an air photograph in 1:22 000 scale for production of a map in 1:25 000 scale by means of the planigraph with good results. The test area was a densely populated region of Germany.

According to this example an aerial photograph in 1:30 000 scale taken in Africa was used with good success for the preparation of a map in

1:50 000 scale. Furthermore, experiments have been made to prepare town plans in 1:10 000 scale by means of coat scribing in the planigraph and using aerial photographs in 1:22 000 scale.

It has been found, however, that the amount of correction work is considerable on large scale maps, so that the advantages of direct coat scribing have been partly compensated. The operators stated that the procedure of direct plotting by coat scribing is only recommandable for scales 1:25 000 and smaller ones.

In this regard a close connection exists between photogrammetry and cartography. Therefore the cartographer has to watch this development, as it will also influence the training of the coming generation.

The development incited by the "Stereomat" will certainly lead to an increase in production, and the cartographer will become more and more a collaborator of the photogrammetrist.

Our present meeting deals with two main subjects of cartography: REVISION and GENERALIZATION. Therefore, we will consider these questions in detail.

REVISION:

The time has passed in which the Offices for Land Registration (cadastre) or for Public Works compiled all information as to topographical changes in order to transmit this information to the Land Survey Offices entrusted with the preparation of topographic maps. At present the changes are too fast and the information channel is too cumbrous. Nowadays the best source of information is the aerial photograph repeatedly taken in all civilized countries with a few years' interval.

Unfortunately, the aerial photograph is a central perspective and in mountainous areas the displacements are of such a degree that the aerial photograph could not be used for the revision of an orthogonal map without troublesome auxiliary constructions. During the last years, various instruments have been designed, changing the aerial photograph into an orthogonal projection. At present this is done only semi-automatically

but in the near future it will probably also be completely automatical by means of the "Stereomat" principle.

The first model of this instrument is the "Orthophotoscope" of Russel F. Bean, U.S.A.. In the plotting instrument appying the system of projection, the model observed with red-green spectacles is scanned. Corresponding to the Z-movement the copy holder with the photographic paper or film is moved up and down. In the exact scanning direction only the respective point of the terrain is exposed by a movable diaphragm, and the small section of the image is produced by the green light. Thus, a new image in orthogonal projection is obtained point by point. After reduction to appropriate scale this image can be directly used as an overlay for the map. Without any auxiliary construction each change in topography is clearly shown. In such places where larger changes occurred, the image can be copied after opaqueing the area concerned onto the original negative plate and the re-scribing can be made immediately.

The Orthophotoscope could neither be used in connection with Stereoplanigraph, Autograph, nor with similar plotting instruments using the optical system. Therefore the Zeiss-Aerotopograph Company constructed an instrument suitable for this purpose and distinguished also by further advantages. In the same way as with the Orthophotoscope this instrument works with a linear scanning of the model. But the photographic process has been transferred to a separate instrument. This consists of one of the conventional Coordinatograph tables, equipped with a special projector. The instrument is installed in a darkroom. By means of an optical system only that point is photographed, which is fixed during the scanning process. A store unit has been intercalated between Stereoplanigraph and photographic transformer (Orthogonal projector), because the scanning of a model takes a certain time, while the process of photographic transformation is four times as quick, i.e. it can be executed within about 20 minutes. However, there are still other reasons for the installation of this store unit. It stores all data given by the planigraph on a punched tape. Later on the store unit transmits these data to the Orthogonal Projector, where the photographic quality can be improved by the accelerated process of photographing. As an additional advantage the data on the tape are stored for

further use. In case of a future air-photography, some years later, the same punched tape may be used for the process of reduction of the same image section without another scanning of the model in the plotting instrument. Even, if a separated contour plate is already available, all information can be taken from this sheet without retracing to the planigraph. If a contour map is available where the contours following one another are drawn in three colours, the punched tape can be established completely automatically, as the instrument can deduce from the consecutive change of colours, if the terrain is ascending or descending.

The orthoscopic image is a map-like representation of the landscape, being free from displacements. Therefore it is an improvement of the mosaic so far used, rendering a far better base for the printing of an aerial mosaic on the back side of a map, which has nowadays become a wide-spread custom.

Now I would like to mention the possibilities of automation in GENERALIZATION. In cartography nearly the same time is needed for checking the cartographic product and for proof-reading of the final drawing, as has been used for the drawing itself. It would be urgently necessary to avoid this time-consuming work or at least to reduce it considerably. This was the reason why I tried to derive automatically a map 1:25 000 scale from a map 1:5 000 scale.

In general a map 1:5 000 scale will be prepared from aerial photographs. In case the plotting instrument has a coordinate printer as e.g. the Ecomat in the planigraph , only by pressing a button the operator can immediately write the coordinates of all typical points as e.g. break points, corners of houses etc. during the compilation of the culture plate. These informations may be used to perform at least a partially automatical map drawing. But, above all, the automatic generalization could be processed after certain superfluous information had been eliminated. But you are certainly right to blame me for not having mentioned the problem of displacement. I entirely agree with you. In such cases the cartographer will certainly have to make some necessary corrections. But in my opinion, there is only a small step to be made to give the order to an instrument, to do -

in case of two approaching traffic routes - the necessary percentage displacement automatically. Naturally these automatic generalizations will always require the correcting hand of the cartographer, but the amount of work will be only small in comparison with the work which is so far necessary.

It can often be stated that a new idea is not as successful as expected. But this does not prove that the basic idea is wrong. It is indispensable that we are ready to discover and to exploit new possibilities. I would like to remind you of the impressing figures which Professor IMHOF mentioned last year at Hanover and which have hardly changed in the meantime:

Only 4 p. c. of the land surface of the earth are covered by large-scale maps

and only 17 p. c. of the land surface of the earth are covered by medium scale maps of about 1 : 75 000.

Considering present conditions we cannot tolerate this result of 150 years of active work. We must find modern ways to meet the urgent need of maps. Already today automation - though still in the beginning - is an indispensable help in cartography. I am convinced that in the near future automation will be used to an ever increasing extent. Let us help, therefore, to keep pace with our time, to understand its requirements, and not to hinder progress by sticking to traditions and obsolete methods. At least we should have finished the cartographic work of the world before we start to other planets. And to achieve this enormous programme, we need

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